I. Title: Underwater survey of the queen conch resource in Puerto Rico

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Report: Final

Date: December 17, 2002

Contract No.: 050-02-000354

Register No.: 4-9-01

II. Abstract

A fishery-independent survey of the queen conch resource was conducted off the west coast of Puerto Rico. A simple random sampling design was used. Paired (and pooled) transects were conducted at each station, with data collected by divers using visual census. Data were collected on conch abundance, length and age, and on habitat type and distribution. Mean density overall was 14.42 conch/ha. The estimated population size of the stratum was 1,284,000 conch. The majority of conch were juveniles. Density was highest in seagrass habitats (15-36 conch/ha). Comparison to past surveys indicate a large, but still statistically non-significant increase in density and population size. Nevertheless, even if the increase is real, total density and abundance are still quite low in comparison to other areas and in consideration with known aspects of conch biology and reproduction.

III. Executive Summary

One of the primary problems for managers is a lack of biological and ecological information on many of the resources. Landings for queen conch declined markedly during the 1980's and have remained low during the 1990's. The previous survey of the conch populations dates to 1996. Since that time management measures limiting catch have been implemented, yet adequate information on stock status needed to assess the effectiveness of these measures is not available. The purpose of this study was to provide queen conch stock assessment information. The objective of this study was to collect and analyze fishery-independent data on the queen conch resources and their environment encompassed in the marine waters within the territorial sea and Exclusive Economic Zone (EEZ) contiguous to the west coast of Puerto Rico.

The queen conch, *Strombus gigas*, resources surrounding Puerto Rico were surveyed using paired-diver visual transects. Sample stations were allocated in a random manner. The area encompassed within the frame of the west coast survey was 890.3 km^2.

A total of 60 stations were surveyed.

Surveys were conducted by divers using underwater scooters. Transect width was four meters. Transect length was variable based on depth. At each station, parallel transects were made (one/diver). All conch were counted. The length was estimated to the nearest 1 cm, and adult age was estimated to one of four relative age classes based on the degree of shell erosion: newly mature, adult, old adult, very old adult. Records were kept of habitat type, depth, time over each habitat type and depth, and time of appearance of each conch observed. Habitat types were recorded using classes based on sediment characteristics or dominant biota. Time and distance measures were used to calculate areas surveyed.

Of the 60 stations sampled, conch were found at 33. Densities ranged from 1.69 to 509.27 conch/ha. Median density for all stations was 2.15 conch/ha; mean density over all stations was 14.42 conch/ha (4.12 - 33.99 95% confidences limits) . The estimated population size in the area based on mean density was 1,284,000 conch.

The majority of individuals observed were juveniles, but the proportion of adults was higher that in previous the previous survey. Adults were largely mature and some very old conch were observed, unlike the past study. Two-thirds of the conch observed were found in seagrass habitats, but these habitats represented less than 15% of the area surveyed. Mean densities in seagrass habitats ranged 15-36 conch/ha. airly evenly distributed among newly mature, mature and old conch.

IV. Purpose

A. One of the primary problems for managers is a lack of biological and ecological information on many of the resources. Landing for many species, such as the queen conch, declined markedly during the 1980's. Managers have a continuing need for current data, and long time series of data are necessary for describe population trends, explain responses to environmental factors and regulatory programs, and predict stock abundance, recruitment, and yield. Information from fishermen (fishery-dependent) is often unreliable because it can be significantly influenced by varying economic conditions. The purpose of this survey was to provide queen conch stock assessment information needed to identify fishery management needs and to implement plans to protect and restore the fishery stocks to support viable productive recreational and commercial fisheries. Previous surveys of the queen conch resource on the west coast were conducted 5 (Mateo 1997; Mateo et al. 1998) and 15 (Torres Rosado 1986) years ago. The first was limited to a small area on the insular shelf off La Parguera, while the more recent survey covered the whole of the west and southwest coast. The effect of recent limitations on conch fishing effort have not been ascertained, but comparison of new data with these past studies offers a basis for this assessment. Thus, information obtained from the current study will enable Puerto Rico to identify, implement and measure the effectiveness of fishery management measures for their territorial waters.

B. The objective of this study was to collect and analyze fishery-independent data on the queen conch resources and their environment encompassed in the marine waters within the territorial sea and Exclusive Economic Zone (EEZ) contiguous to Puerto Rico along the west and southwest coasts.

V. Approach

A. The queen conch, *Strombus gigas*, resources on the west and southwest coasts of Puerto Rico were surveyed using paired-diver visual transects. Sample stations were selected in a randomized manner. A prior survey (Mateo 1997), stratified on the basis of expected abundances as determined by historical fishing patterns, showed that random sampling would approximately allocate effort proportionally by area. Stations were selected randomly from a grid set at 0.1 min latitude by 0.1 min longitude. Sixty stations were targeted.

Estimates of abundance and density of queen conch were made from visual surveys along strip-transects. Surveys were conducted by divers using underwater scooters. Transect width was four meters. Transect length was variable based on depth, but maximum survey time was set at 45 minutes, and no dives exceeded the no-decompression limits for diving safety. At each station, parallel transects were made (one/diver).

Global Positioning System was used to locate the beginning and end of each transect. A buoy was dropped at the starting point of each transect, from which divers followed a fixed compass heading for a set period of time, the latter determined by depth. Prior to conducting a transect, a four-meter long marker was placed on the bottom to calibrate transect width.

For each transect, depth and start time were recorded. While conducting a transect, the scooter was kept approximately one meter above the substrate so that path width remained constant at 4 meters. All conch were counted. The length of all individuals were estimated to the nearest 1 cm, and if an adult its age was estimated to one of four relative age classes based on the degree of shell erosion: newly mature, adult, old adult, very old adult. Definitions of these are given in Table 1. Records were kept of habitat type, depth, time over each habitat type and depth, and time of appearance of each conch observed. Habitat types were recorded using classes based on sediment characteristics or dominant biota, such as Sand, Algae, Gorgonian, *Thalassia, Syringodium, Halemida, Halophila*, Mud, Coral, Hard Bottom, and Rubble. Combinations of these were used to classify areas of mixed habitat.

Transect length was obtained by calculating the distance between the beginning and end points of each transect. Total area was calculated by multiplying the distance of each transect by the transect width. Area for each habitat was calculated by multiplying the total area by the percentage of time spent over each habitat. Densities for each habitat were derived by dividing the number of conch per habitat type by the total area of that habitat type per transect. Overall abundance was estimated from the data on density/station. Confidence limits (95%) were obtained through bootstrapping, using 4000 trials. Length (juvenile, adult) and age (adult) frequency distributions were determined.

Prior to the start of the actual survey, divers were trained to identify live conch, maintain speed and transect width, and to estimate length and adult age-classes. A reference collection of adult conch for each age group was maintained.

The area included in the survey for the west coast was bounded on the north by a line extending from Pta. Guanajibo northwest to the insular shelf-edge. To the south the limit was a line running from Pta. Brea south to insular shelf-edge. The outer boundary of the shelf edge was the 16 fathom depth contour. The area encompassed within these boundaries was 890.3 km^2.

B. The work was performed cooperatively between the Department of Marine Sciences, University of Puerto Rico - Mayaguez (DMS) and the Fishery Research Laboratory of the Department of Natural and Environmental Resources (FRL). Principal investigator for the survey was Richard S. Appeldoorn of DMS who had responsibilities for sample-site selection, diver training, conducting the survey and analyzing the results. Nilda Jimenez (DMS) was the field coordinator and had on-site responsibility for diver training and data collection. A total of four divers were trained and utilized in the survey. Aida Rosario (FRL) was the liaison between the FRL and the DMS and had responsibility for boat scheduling and maintenance. In the latter part of the survey, due to boat problems, sampling was conducted using DMS boats, and subsequently boat time was chartered from Capt. Angel Nazario

VI. Findings

A. A total of 60 stations were sampled. Table 2 gives the location, and sampling date for each station. Table 3 reports the results from each station. The total area surveyed was 23.58 ha.

Of the 60 stations sampled, conch were found at 33. This is a lower proportion than observed in the previous survey. At the stations where conch were found, densities ranged from 1.69 to 509.27 conch/ha. Density data were highly skewed. Median density for all stations was 2.15 conch/ha; for only those stations with conch it was 5.68 conch/ha.

Mean density over all stations was 14.42 conch/ha, with lower and upper 95% confidences limits of 4.12 and 33.99 conch/ha, respectively. Conversions to total abundances are given in Table 4. The one station (No. 58) where 35 juvenile and 5 adult conch were found strongly impacts this result and is responsible for both an elevated mean value and large confidence limits. The density at this station was an order of magnitude greater than observed elsewhere in the study. Replacing this estimate with the observed density of adults only (N=5; density = 13.58 conch/ha) resulted in a mean density of 6.163 (95% CI: 3.627 - 9.122).

Sand was the most abundant habitat found, representing over 32% of the area surveyed (Table 5). However, the density of conch in this habitat was low (3.95 conch/ha). Conch were most dense in seagrass habitats, with the highest densities (conch/ha) recorded for *Thalassia* (36.58), *Thalassia-Syringodium* (26.99), *Syringodium* (25.87), algae with *Halophila* and *Syringodium* (22.91) and sand with *Thalassia* (15.27). Of all conch observed, 67.8% were found in these habitats. Of these habitats, only *Thalassia* was abundant, representing 8.5% of the area sampled. The other high-density habitats represented less than 2% each of the area sampled.

The majority (59.7%) of individuals observed were juveniles (89 of 149). Transcribed into densities (conch/ha), juveniles (10.14) represented 70% of the conch in the population. Adult density was 4.29. Juveniles ranged from 7 to 22 cm in size (Figure 1). For juveniles, the distribution reflects a young year class (1+) peaking in the 10-13 cm range, an older year class (2+) peaking in the 15-17cm range, and the remnants of a third year class (3+) now maturing into adults. The skewed peaks may reflect that fact that conch were collected in two periods separated by a period when no surveys were done. Of the adults, 16.7% were old, and 3.3% were classified as being very old.

Compared to past surveys (Table 4, Figure 2) the estimate of mean density of conch on the west coast of Puerto Rico is higher, but the difference is not statistically significant due to the large error bars. Elimination of the juveniles from Station 58 resulted in a slight decrease in estimated mean abundance. Density estimates for both juveniles and adults increased since the past survey. In 1996 juvenile and adult densities were 6.24 and 2.24 conch/ha, respectively. Corresponding values in 2001/2 were 10.14 and 4.29 conch/ha, respectively. Proportionally, there was a greater increase in adult density. As a result, the estimated ratio of juveniles to adults (based on densities) decreased compared to past years (e.g., 2.79 in 1996 vs 2.36 in 2001/2). The (non-significant) increase in adults suggests either greater juvenile recruitment over the past years (supported by the higher juvenile density found in this survey) and/or reduced fishing pressure. These results are also supported by the observation of very old conch, not seen in the previous survey. Thus, there are indications that there has been an improvement in the west coast conch population since the last survey. However, these differences are not statistically significant, and more importantly, the density levels are still very low compared to areas with large conch fisheries, especially considering observed relationships between density and subsequent larval abundance and juvenile recruitment (Stoner).

B. Two problems occurred during the study. The first concerned the time lag between the beginning and end of the survey. The lag was due first to the breakdown of boat supplied by the Fisheries Research Laboratory, which required alternate arrangements to be made, and subsequently due to personal injury (not job related) of the dive team leader. This delay could have had two effects, both related to the desire for the survey to represent a point estimate 9with respect to time) of the status of the population. First, the increase in average size of conch due to growth between the beginning and end of the survey would slur the size/age frequency distributions. Secondly, any seasonal changes that occurred in abundance to due recruitment or in habitat distribution would be integrated across the samples. While this could impact estimates, the confidence limits on all estimates are large, so it is extremely unlikely that such potential effects would have affected the interpretation of the results.

The other problem was that for a few of the transects the final position (latitude, longitude) could not be ascertained. Estimating transect length using average speed is not a very accurate substitute, and this could have impacted the results. However, our approach should have at least been unbiased, and again considering the large confidence limits in all estimates should not greatly affect the interpretation of results.

C. There is no specific need for additional work within the context of the contract. However, future availability of a detailed habitat map covering the SEAMAP area would allow the results to be re-analyzed using habitat/dpeth specific, post-stratification. This may allow greater precision of the estimates (i.e., reduced confidence limits), which would greatly facilitate the detection of trends over time.

VII. Evaluation

Despite comments of Part VI, it was felt that all project goals and objectives were attained for the assessment of the west coast conch resource.

VII. Literature Cited

Mateo, I. 1997. Spatial variations in stock abundance of queen conch, *Strombus gigas*, (Gastropoda: Strombidae) in the west and east coast of Puerto Rico. M.S. Thesis, UPR-Mayaguez. 75 p.

Mateo, I., R. Appeldoorn, W. Rolke. 1998. Spatial variations in stock abundance of queen conch, *Strombus gigas* (Gastropoda: Strombidae), in the west and east coast of Puerto Rico. Proc. Gulf Caribb. Fish. Inst. 50: 32-48.

Torres Rosado, Z.A. 1987. Distribution of two mesogastropods, the queen conch, *Strombus gigas* Linnaeus, and the milk conch, *Strombus costatus* Gmelin, in La Parguera, Lajas, Puerto Rico. M.S. Thesis. Univ. Puerto Rico, Mayaguez, PR. 37 pp.

List of Figures

Table 1. Definitions of adult queen conch age classes. Bold numbers in parentheses give lip-thickness measures for reference specimens.

Newly Mature Adult	Flared lip starting to grow or very thin (lip generally <5 mm thick). Periostrocum tan and clean. Often the lip is thin enough to allow the perisotrocum to give color to the underside of the lip. **(4, 7)**
Adult	Flared lip is fully formed, with minimal to moderate erosion. Periostrocum tan but may be sand covered or with some algal growth, Lip underside generally white with pink interior. **(15, 15)**
Old Adult	Outer lip starting to erode (as viewed from bottom). Top of shell still well formed, but periostrocum is lost and spines have rounded, with moderate erosion and fouling on the outside shell. Lip under-side may have platinum color, with darker pink interior. **(30, 33)**
Very Old Adult	Lip is very thick and flared portion may be completely eroded away, Outer shell is highly fouled and eroded, often resulting in a short total length. Viewed from the underside, the lip is squared off, the white portion is often completely eroded and the interior is a dark pink. **(42, 59)**

Table 2 Date, location, duration (minutes) and start and end depth of each stations for conch transects.

Station No.	Date	Start Latitude	Start Longitude	End Latitude	End Longitude	Time	Depth (ft) Start	Depth (ft) End
1	8/31/2001	18°08'080"N	67°23'989"W	18°07'939"N	67°23'989"W	15	80	80
2	8/31/2001	18°08'010"N	67°24'070"W	18°08'060"N	67°24'320"W	15	80	85
3	8/31/2001	18°09'030"N	67°16'010"W	18°08'600"N	67°15'900"W	18	50	28
4	8/31/2001	18°09'060"N	67°18'000"W	18°09'121"N	67°17'736"W	15	20	29
5	9/22/2001	17°54'090"N	67°03'407"W	17°54'104"N	67°03'850"W	20	55	55
6	9/22/2001	17°55'051"N	67°02'102"W	17°55'187"N	67°02'407"W	21	55	55
7	9/22/2001	17°55'090"N	67°05'010"W	N/A	N/A	20	55	55
8	9/22/2001	17°56'017"N	67°04'008"W	17°56'198"N	67°04'156"W	25	45	45
9	10/19/2001	17°55'110"N	67°06'160"W	N/A	N/A	15	35	25
10	10/19/2001	17°55'491"N	67°05'924"W	17°55'686"N	67°06'349"W	15	40	50
11	10/21/2001	17°54'025"N	66°59'035"W	17°54'199"N	66°59'331"W	15	50	60
12	10/21/2001	17°54'064"N	67°00'013"W	N/A	N/A	15	60	60
13	11/2/2001	17°53'217"N	67°01'069"W	17°53'500"N	67°01'269"W	15	60	63
14	11/2/2001	17°53'000"N	67°05'050"W	17°53'157"N	67°05'332"W	15	60	60
15	11/2/2001	17°53'069"N	67°04'047"W	17°53'237"N	67°04'157"W	14	70	65
16	11/2/2001	17°54'015"N	67°04'089"W	17°54'214"N	67°04'164"W	20	45	45
17	11/3/2001	17°52'971"N	67°07'983"W	17°53'155"N	67°08'010"W	11	100	100
18	11/3/2001	17°53'600"N	67°07'030"W	N/A	N/A	15	84	88
19	11/3/2001	17°54'034"N	67°05'040"W	17°54'332"N	67°05'025"W	15	83	57
20	11/10/2001	17°53'600"N	67°09'200"W	17°53'797"N	67°09'461"W	19	90	73
21	11/10/2001	17°53'736"N	67°10'248"W	17°53'725"N	67°10'417"W	15	80	100
22	11/10/2001	17°57'005"N	67°10'715"W	17°56'708"N	67°10'531"W	18	20	20
23	11/10/2001	17°56'809"N	67°09'212"W	17°56'854"N	67°09'109"W	20	24	23
24	11/11/2001	17°54'486"N	67°09'326"W	17°54'673"N	67°09'289"W	16	60	60
25	11/11/2001	17°55'003"N	67°10'302"W	17°55'025"N	67°10'550"W	20	40	40
26	11/11/2001	17°55'498"N	67°08'405"W	17°55'492"N	67°08'608"W	22	35	35
27	11/11/2001	17°56'202"N	67°08'502"W	N/A	N/A	16	30	30
28	11/12/2001	17°55'600"N	66°59'691"W	N/A	N/A	15	70	70
29	11/12/2001	17°55'326"N	67°00'615"W	17°55'595"N	67°00'492"W	18	70	70
30	4/27/2002	18°08'743"N	67°22'765"W	18°08'363"N	67°22'675"W	15	65	75
31	4/27/2002	18°05'542"N	67°22'958"W	18°06'182"N	67°23'000"W	15	80	80
32	4/27/2002	18°05'995"N	67°24'499"W	18°05'805"N	67°24'526"W	15	65	60
33	4/27/2002	18°04'783"N	67°24'535"W	18°04'478"N	67°24'525"W	16	67	67
34	4/27/2002	18°08'082"N	67°19'875"W	18°08'003"N	67°20'160"W	16	45	50
35	4/27/2002	18°07'333"N	67°17'380"W	N/A	N/A	17	25	24
36	4/27/2002	18°08'189"N	67°15'304"W	N/A	N/A	15	10	10
37	4/28/2002	18°05'514"N	67°20'995"W	18°05'724"N	67°21'047"W	17	80	77
38	4/28/2002	18°06'197"N	67°20'529"W	18°05'995"N	67°20'720"W	16	67	75
39	4/28/2002	18°09'719"N	67°20'214"W	18°09'276"N	67°20'520"W	15	35	50
40	4/28/2002	18°09'395"N	67°13'613"W	18°09'097"N	67°13'702"W	15	30	30
41	4/5/2002	18°05'161"N	67°19'270"W	18°05'317"N	67°18'933"W	15	77	77
42	4/5/2002	18°03'918"N	67°19'060"W	18°04'215"N	67°18'829"W	15	80	90

Table 2. (Continued)

43	4/5/2002	18°03'983"N	67°16'828"W	18°04'030"N	67°16'580"W	15	70	77
44	4/5/2002	18°03'603"N	67°16'196"W	18°03'648"N	67°16'201"W	15	45	45
45	4/5/2002	18°04'852"N	67°14'866"W	18°04'862"N	67°14'660"W	15	15	15
46	5/5/2002	18°03'920"N	67°14'025"W	18°03'972"N	67°14'274"W	15	65	65
47	5/5/2002	18°02'815"N	67°16'556"W	18°02'935"N	67°16'707"W	15	65	65
48	5/5/2002	18°01'040"N	67°13'366"W	18°01'023"N	67°13'215"W	15	50	50
49	5/18/2002	18°01'239"N	67°21'266"W	18°01'376"N	67°21'077"W	15	60	67
50	5/18/2002	17°59'478"N	67°21'075"W	17°59'775"N	67°21'053"W	18	45	35
51	5/18/2002	17°59'792"N	67°20'149"W	17°59'893"N	67°20'115"W	15	50	50
52	5/19/2002	18°01'409"N	67°17'466"W	18°01'809"N	67°17'472"W	15	75	79
53	5/19/2002	18°01'939"N	67°19'314"W	18°02'143"N	67°19'197"W	15	80	77
54	5/19/2002	18°00'587"N	67°16'406"W	18°00'968"N	67°16'446"W	15	55	40
55	5/19/2002	18°00'606"N	67°14'393"W	18°00'673"N	67°14'324"W	15	35	26
56	5/19/2002	17°59'281"N	67°13'900"W	17°59'365"N	67°13'798"W	15	40	40
57	5/19/2002	17°58'071"N	67°13'798"W	17°58'130"N	67°13'843"W	15	40	40
58	5/20/2002	17°56'169"N	67°14'147"W	17°56'211"N	67°14'181"W	18	40	40
59	5/20/2002	17°57'787"N	67°16'138"W	17°58'160"N	67°16'365"W	16	40	40
60	5/20/2002	17°59'250"N	67°15'157"W	17°59'332"N	67°15'382"W	15	40	40

Table 3 Depth range, area surveyed, number and density of conch at each station

Station Number	Depth		Area (m^2)	Number of Conch Observed			Density (conch/ha)		
	Start	End		Total	Adults	Juveniles	Total	Adult	Juvenile
1	80	80	2,089	0			0	0	0
2	80	80	3,597	0			0	0	0
3	50	28	6,556	0			0	0	0
4	20	29	3,825	0			0	0	0
5	55	55	6,249	0			0	0	0
6	55	55	4,748	0			0	0	0
7	55	55	4,910	0			0	0	0
8	45	45	3,398	0			0	0	0
9	35	25	3,683	0			0	0	0
10	40	50	6,651	0			0	0	0
11	50	60	4,905	1	1		2.04	2.04	0
12	60	60	3,683	1		1	2.72	0	2.72
13	60	63	5,053	0			0	0	0
14	60	60	4,607	2		2	4.34	0	4.34
15	70	65	2,933	0			0	0	0
16	45	45	3,132	3	3		9.58	9.58	0
17	100	100	2,753	0			0.00	0	0
18	84	88	3,683	5	1	4	13.58	2.72	10.86
19	83	57	4,420	0			0	0	0
20	90	73	4,697	1		1	2.13	0	2.13
21	80	100	2,388	1	1		4.19	4.19	0
22	20	20	5,108	7		7	13.70	0.00	13.70
23	24	23	1,598	7	3	4	43.82	18.78	25.04
24	60	60	2,819	1		1	3.55	0.0	3.55
25	40	40	3,511	9	7	2	25.63	19.94	5.70
26	35	35	2,863	16	11	5	55.88	38.42	17.46
27	30	30	3,928	9	2	7	22.91	5.09	17.82
28	70	70	3,683	0			0	0	0
29	70	70	4,346	2	2		4.60	4.60	0
30	65	75	5,771	0			0	0	0
31	80	80	9,501	4	3	1	4.21	3.16	1.05
32	65	60	2,841	3	1	2	10.56	3.52	7.04
33	67	67	4,521	2		2	4.42	0	4.42
34	45	50	4,180	2	2		4.78	4.78	0
35	25	24	4,174	3	2	1	7.19	4.79	2.40
36	10	10	3,683	4	1	3	10.86	2.72	8.15
37	80	77	3,196	3	3		9.39	9.39	0
38	67	75	4,024	2		2	4.97	0	4.97
39	35	50	7,851	0			0	0	0
40	30	30	4,590	1		1	2.18	0	2.18
41	77	77	5,279	3		3	5.68	0	5.68
42	80	90	5,473	0			0	0	0
43	70	77	3,562	1	1		2.81	2.81	0
44	45	45	670	2	2		29.83	29.83	0
45	15	15	2,905	0			0	0	0
46	65	65	3,591	0			0	0	0
47	65	65	2,772	1	1		3.61	3.61	0

Table 3. (Continued)

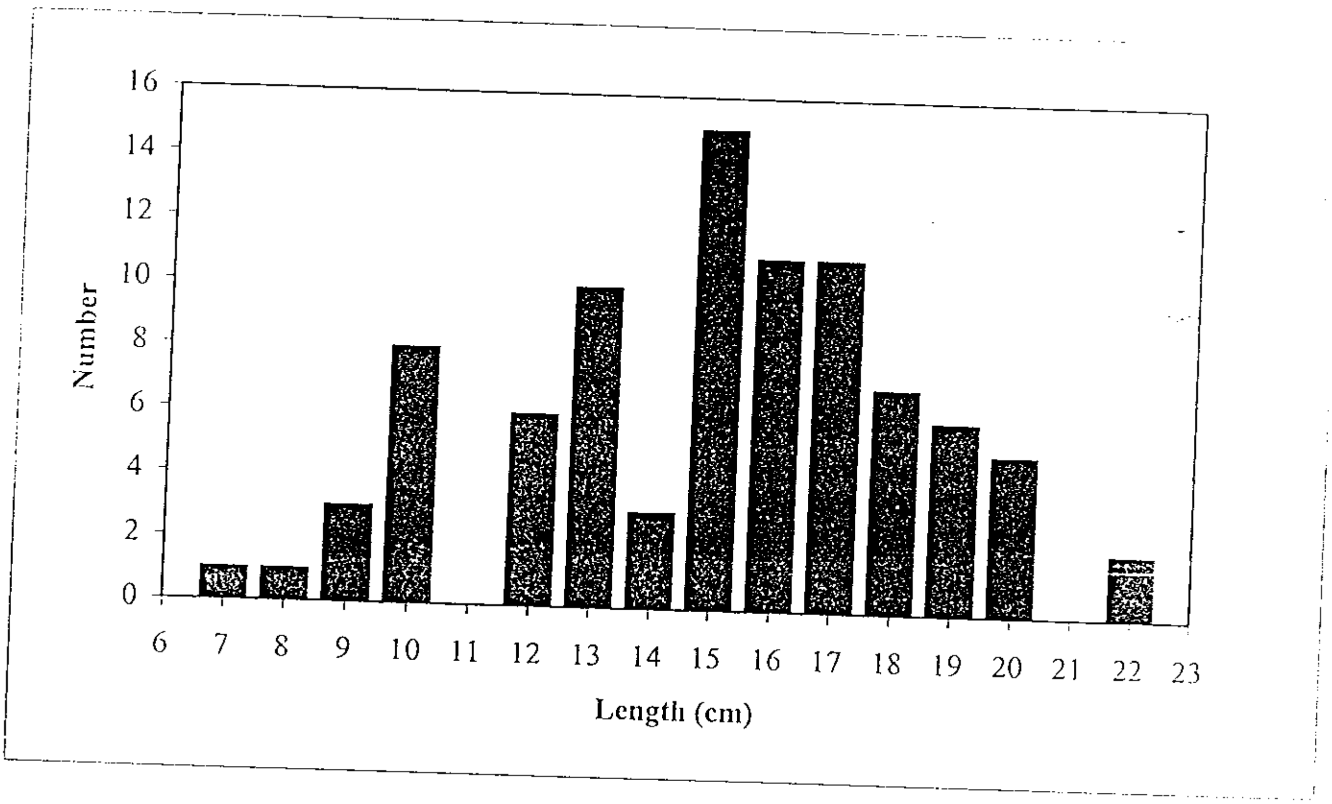
48	50	50	2,142	0			0	0	0
49	60	67	3,348	0			0	0	0
50	45	35	4,411	4	4		9.07	9.07	0
51	50	50	1,571	0			0	0	0
52	75	79	5,927	1	1		1.69	1.69	0
53	80	77	3,443	1	1		2.90	2.90	0
54	55	40	5,673	0			0	0	0
55	35	26	1,389	3	1	2	21.59	7.20	14.39
56	40	40	1,901	0			0	0	0
57	40	40	1,080	0			0	0	0
58	40	40	785	40	5	35	509.27	63.66	445.61
59	40	40	6,386	0			0	0	0
60	40	40	3,395	4	1	3	11.78	2.95	8.84
				Total =	60	89	Mean =	4.29	10.13

Table 4. Current and past estimates of conch density and abundance on the west coast of Puerto Rico. Confidence limits (CL) are at 95%. * indicates estimate is adjusted by eliminating juveniles at Station 58.

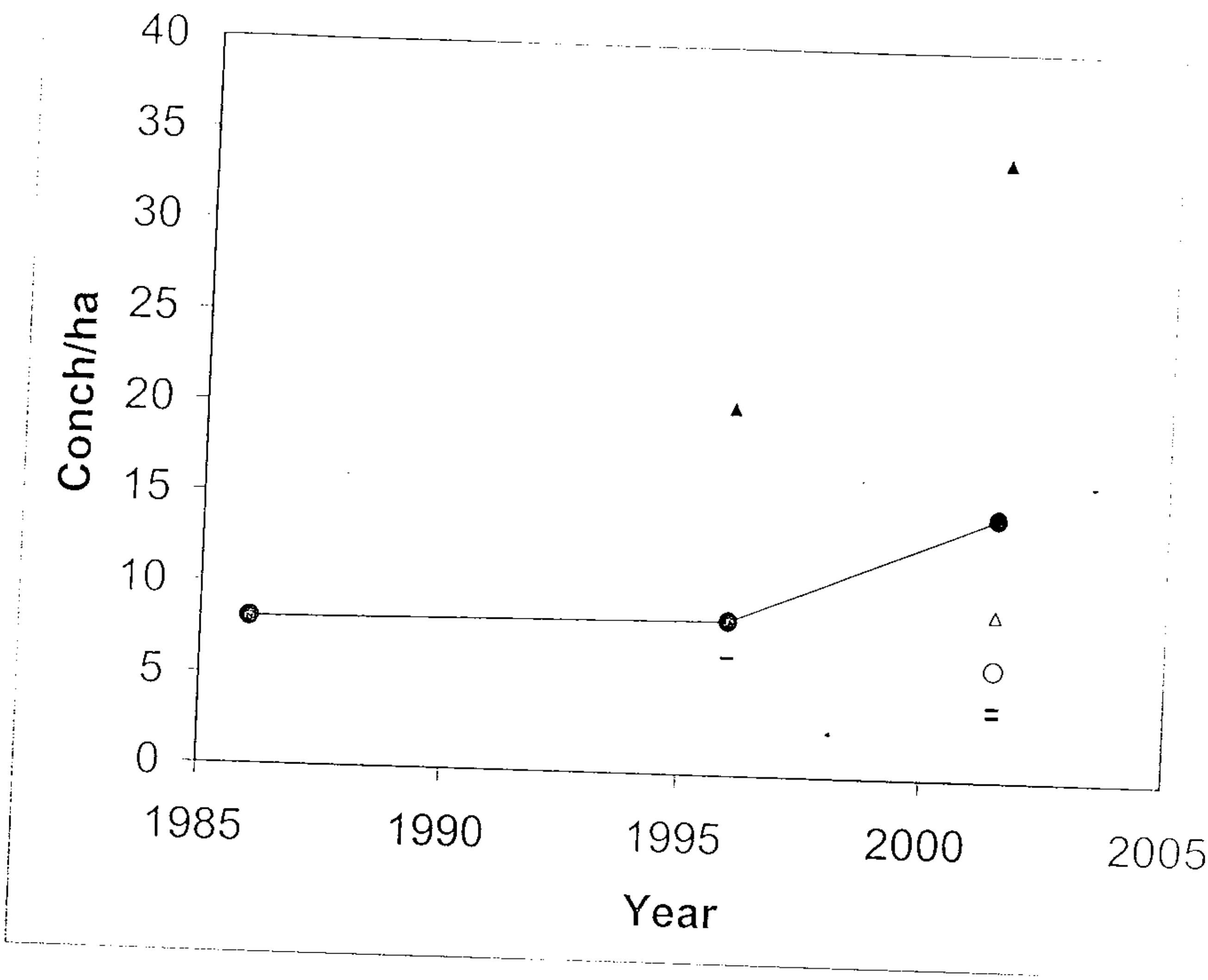
Year	Density (conch/ha)			Abundance		
	Mean	Lower CL	Upper CL	Mean	Lower CL	Upper CL
2001/2	14.42	4.12	33.99	1,283,813	366,804	3,026,130
2001/2*	6.163	3.627	9.122	548,692	322,912	812,132
1996	8.49	6.51	20.22	755,844	580,000	1,800,000
1986	8.11					

Table 5. Density of conch by habitat type. Habitat type is ranked by area surveyed.

Bottom Type	Total Area (m^2)	% Area	# Conch	Density (conch/ha)	Rank Density
Sand	76,042	32.24	30	3.95	7
Coral	30,331	12.86	1	0.33	8
Hard bottom	21,105	8.95	10	4.74	6
Thalassia	20,227	8.58	74	36.58	1
Algae	19,466	8.25	4	2.05	
Sand with algae	18,808	7.97	6	3.19	
Sand & gorgonians	17,206	7.30	0	0	
Sand with *Syringodium*	6,386	2.71	0	0	
Sand with *Halophila*	4,927	2.09	0	0	
Gorgonian &hard ground	4,748	2.01	0	0	
Syringodium	4,252	1.80	11	25.87	3
Algae with *Halophila* and *Syringodium*	3,928	1.67	9	22.91	4
Hard bottom with sand	3,825	1.62	0	0	
Sand/*Thalassia*	1,964	0.83	3	15.27	5
Gorgonians	1,147	0.49	0	0	
Hard bottom with some corals and gorgonians	783	0.33	0	0	
Thalassia and *Syringodium*	371	0.16	1	26.99	2
Sand & coral	337	0.14	0	0	



16
14
12
10
8
6
4
2
0
Number
6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Length (cm)



40
35
30
25
20
15
10
5
0
Conch/ha
1985
1990
1995
2000
2005
Year